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A Key to the Larvae of the Polychaetous annelids of the Hawaiian Islands

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ABSTRACT

Larvae representing eight families of polychaetes collected from Hawaiian waters are described and a taxonomic key for these families is provided. Larvae samples were collected from the Ala Wai Canal and Kaneohe Bay, Oahu, maintained in petri dishes in the laboratory where the accompannying photomicrographs and drawings were made. Representative specimens were preserved for future reference. A bibliography dealing with polychaete larvae from other locations throughout the world is included.

INTRODUCTION

Polychaetes are important constituents of tropical reef communities. They are vital as: 1) a food source for other organisms, 2) predators, 3) as borers and foulers of hard substrates. Polychaetes frequently occur in very high densities: Kohn and Lloyd (1973) found 49,000 polychaetes/m2 on the shallow reefs of the Indian Ocean; while Brock and Brock (1977) record 50,100-127,900 polychaetes/m^2in samples of coral rubble collected from Kaneohe Bay, Oahu, Hawaii. At such high densities they are often important links in the trophic chain. The diet of some reef fishes and invertebrates is known to consist almost exclusively of polychaetes. Hiatt and Strasburg (1960) found that polychaetes are highly utilized as food items by certain reef fishes including members of the families Holocentridae, Dussumieridae, Hemiramphidae and Priacanthidae, in the Marshall Islands. Polychaetes are the most common food organism of seven species of Caribbean reef fishes including *Chaetodon striatus* and *Halichoeres maculippina* where polychaetes comprise 58.7% and 47.1% of the diet respectively (Randall, 1967). Kohn (1959) observed that of the sixteen species of *Conus* ("cone shells") collected from the reef platforms of the Hawaiian Islands, ten species feed exclusively on polychaetes; polychaetes comprise a lesser, but significant part of the diet of three additional species of the genus. These thirteen species of *Conus* prey on at least 23 different species of errant and sedentary polychaetes.

The feeding methods of polychaetes are varied, ranging from filtration and suspension feeding to active predation. The common families are characterized by particular feeding types. Syllids are thought to feed on sponges, bryozoans and hydroids by piercing the bodywall and extracting internal fluids of the prey. Nereids, which are omnivores, use their mouth parts to grasp such prey as amphipods and other polychaetes or to rasp algae from hard substrates. Spionids select food particles from the substrate near their tube using a pair of prostomial palps. Filter-feeding is illustrated by the serpulids which use their ciliated branchial crown to strain particles from the surrounding water (Day, 1967).

Many polychaetes are of economic importance because of their ability to settle on or bore into various substrates. Serpulids are calcareous tube-building worms. Some, such as, *Hydroides elegans* and *Hydroides dirampha* are of interest because they foul ship hulls, pier pilings, water intake pipes and other marine structures (Bailey-Brock, 1976). Some spionids of the genera *Polydora* and *Boccardia* (Blake and Evans, 1975) and the cirratulid *Dodecaceria sp.* (Blake, 1969a) are known to bore into the shells of molluscs. Of particular concern to oyster culturists in Hawaii, and throughout the world, is the spionid *Polydora websteri* which bores into the shells of a number of species of oyster. While the worm does not eat the oyster or directly harm it, they do weaken the shell. The worm lines its tube with mud which is collected from the surrounding area and may contain high concentrations of bacteria such as *Escherichia coli* which can render the oyster unmarketable.

In order to understand the geographic distribution of adult worms and the polychaete communities typical of tropical reefs and temperate seas, a study of the larval forms is necessary. Collection of benthic adult polychaetes can be difficult and time consuming, often requiring laborious chipping of coral rubble (Brock and Brock, 1977) or sifting of large volumes of decaying mud. However, benthic polychaetes typically have planktonic larvae, and it is usually easier to sample plankton rather than benthos. Seasonal plankton collections in a study area can provide data on the polychaete larvae present and their spatial and temporal distribution. This is useful for population studies and for monitoring species occurrence. To date most of the work on larval polychaetes has been concerned with fouling types, particularly the sedentary tube-builders (Serpulidae and Sabellariidae) from temperate waters.

There is no previous literature available on Hawaiian polychaete larvae. The greatest portion of work in this field has been conducted in Europe, and deals with temperate species, their development, settlement behavior and metamorphosis.

British investigators of polychaete larvae include D.P. Wilson who has studied the larval development of Sabellariids (1929; 1968 a,b; 1970a,b; 1976) and other worms such as the spionids, *Polydora ciliata* and *Polydora hoplura* (1928), the nereid, *Nereis pelagic* (1932), and the capitellid, *Notomastus latericeus* (1933). Wilson also investigated the influence of substrate type on the settlement and metamorphosis of the capitellid, *Notomastus latericeus* (1937) and the opheliid, *Ophelia bicornis* (1948; 1953; 1954; 1955). Other British researchers, such as de Silva, 1962; Gee, 1965; Knight-Jones, 1951, 1953; Knight-Jones, Bailey, and Isacc, 1971; Stebbing, 1972; Williams, 1964; and Wisely, 1960, have studied the chemical stimulation of, and behavior during settlement of serpulid larvae. Many of the references dealing with the larvae of temperate water polychaetes have been included in this paper as they are useful for taxonomic purposes.

Although tropical polychaetes are important on reefs, there has been little research on their larval development, reproductive seasonality and settlement behavior. Marsden (1960) describes eight species of polychaete larvae from the Caribbean and Eckelbarger (1975, 1976) investigated the development of two species of Sabellariids from the reefs off the eastern coast of Florida. These papers are among the few relevent works on tropical or near tropical polychaetes and their larvae. Additional research on tropical species is necessary to establish the effects of year-round warm water temperatures, and continuous productivity, on the reproductive biology of polychaetes.

With the rapid development of aquaculture in tropical regions it is imperative to increase our knowledge of tropical polychaete, larvae particularly those which might be of economic importance as pests of aquaculture organisms or those that could be utilized as a food source for these organisms. Before detailed studies can be conducted, though, it is necessary to be able to identify the larvae.

This paper is intended as a compendium of information on polychaete larvae with particular emphasis on those most frequently encountered in Hawaiian plankton, including a taxonomic key to the families. This paper, and the references cited in it provides a starting point for any future investigations of Hawaiian polychaete larvae.

MATERIALS AND METHODS

Polychaete larvae were obtained by two methods: tows with a plankton net (mesh aperature 125μ); and laboratory fertilization of gametes from ripe adults.

Regular sampling of the plankton can yield specific information on reproductive seasonality, ecology and distribution patterns of the larvae of certain polychaetes. However, one can seldom follow the complete development of a particular individual. After numerous samplings of the plankton it it usually possible to piece together the life history of a species but gaps often remain, particularly in the early development.

Rearing of larvae from gametes withdrawn from mature adults is necessary to gain information on the embryology and development of a species. A disadvantage to this approach is the difficulty in maintaining uncontaminated cultures of gametes and embryos.

After collection, larvae were cultured in 60 x 15 mm disposable petri dishes with a maximum of ten larvae/dish. Sea water collected from the Ala Wai Canal (McCully St. bridge) at a depth of 1m was used for maintaining the larvae; it was changed every three days. Upon death of a larva, or development of bacterial or protozoan cultures, surviving larvae were transfered to a new dish with clean water. The food source and tube-building material for the larvae consisted of organic material collected from the bottom of a salt water aquarium.

Larvae were retained in their petri dishes during observation under low magnification (10-30x) with a Binolux dissecting microscope; single larvae were transfered to a depression slide with water and a cover slip for observation at higher magnification (50-100x) with a Monolux compound microscope. Photomicrographs were taken with a 35mm Pentax Spotmatic camera and a Ricoh camera-microscope adaptor. Photomicrographs and free-hand drawings were made of both live and preserved specimens at 100x magnification. Larvae were observed only for short periods of time to prevent desiccation and death.

When possible representative larvae were preserved for future reference. Larvae were prepared for fixation by adding magnesium sulfate crystals to the dish containing the larvae until the larvae were relaxed. They were then preserved either in 75% ethanol or 10% formalin. Whole mounts of the larvae were made using polyvinyl lactophenol in order to render the tissue transparent and the setae readily visible under the compound microscope.

The important morphological characteristics of polychaete larvae are: the number of setigers (segments with setae); types of setae; number and color of eyespots; color and pattern of chromatophores or other pigmentation; the presence or absence of dorsal, ventral or anal cirri, or prostomial antennae and tentacular cirri. Taxonomic keys for the identification of adult polychaetes are seldom useful for the identification of larvae because of the changes that occur at metamorphosis.

A glossary of terms has been included as appendix I.

The following papers contain descriptions and illustrations of a broad range of polychaete larvae and have been utilized during the course of this study and are included here for their general usefulness. These and other papers are listed under the specific family for which they are applicable: Bhaud, 1967; Blake, 1975 a,b,c; Fewkes, 1883; Grassé, 1959; Hannerz, 1956, 1961; Marsden, 1960; Nolte, 1942; Thorson, 1946; and Vannucci, 1959.

A paper that deals with the rearing techniques for polychaete larvae is Dean and Mazurkiewicz in Smith and Chanley, 1972.

Key to the Families of Common Hawaiian Planktonic Polychaete Larvae

1	Dorsum bears elytra (scales) (Fig. 1)	Aphroditidae p.10
	Elytra lacking	2
2(1)	Parapodium with a paddle or leaf-shaped dorsal cirrus(Fig. 2)	Phyllodocidae p.12
	Cirrus otherwise or lacking	3
3(2)	Comound setae present (Fig. 3)	Nereidae p.14
	Simple setae only	4
4(3)	Two to three pairs of black eyespots; simple capillary setae may be smooth or serrate(Fig. 5) pair of grooved prostomial palps of variable length may be present; dorsal melanophores present (Fig. 7)	Spionidae p.18
	Setae, head structures and pigmentation otherwise	5
5(4)	Hooded hooks (Fig. 16b) present, eyespots red	6
	Hooded hooks absent; eyespots red or black	7
6(5)	Setae all hooded hooks; one pair of short prostomial palps and a single anal projection; two to three pairs of red eyespots present (Fig. 13)	Chaetopteridae p.35
	Setae consist of simple capillaries and hooded hooks; prostomial and anal projections lacking; one pair of red eyespots (Fig. 15)	Capitellidae p.39
7(5)	Three black eyespots; anal cirri present (Fig. 17)	Opheliidae p.43
	One pair of red eyespots (except in trochophore); setae are geniculate (Fig.19); anal cirri absent	Serpulidae p.45

Family-Aphroditidae (Scale worms)

Description of Larva

A typical six setiger larva (Fig. 1) has a total of three pairs of clear dorsal elytra (scales), a kidney-shaped prostomium with two pairs of black eyespots which may be fused, five antennae, and a pair of prostomial palps. The setae are serrated capillaries, each segment without an elytra bears a dorsal cirrus. There is a pair of anal cirri on the pygidium, these are easily lost and so may not be seen. The number of palps, antennae and cirri are difficult to determine in live specimens because of rapid movement and they are hidden by the elytra.

Remarks

Adult scale worms are benthic detritivores which inhabit muddy regions (Day, 1967) and are also components of rocky intertidal, pier piling and wharf communities (Blake, 1975c).

Genera reported from Hawaii as adults

Arctonoe, Eunoe, Harmothoe, Hololepidella, Iphione, Kernaderella, Lepidasthenia, Lepidonotus, Paralepidonotus, Polynoe, Thormore

References to larvae

Blake, 1975c; Cazaux, 1968; Daly, 1972; Thorson, 1946

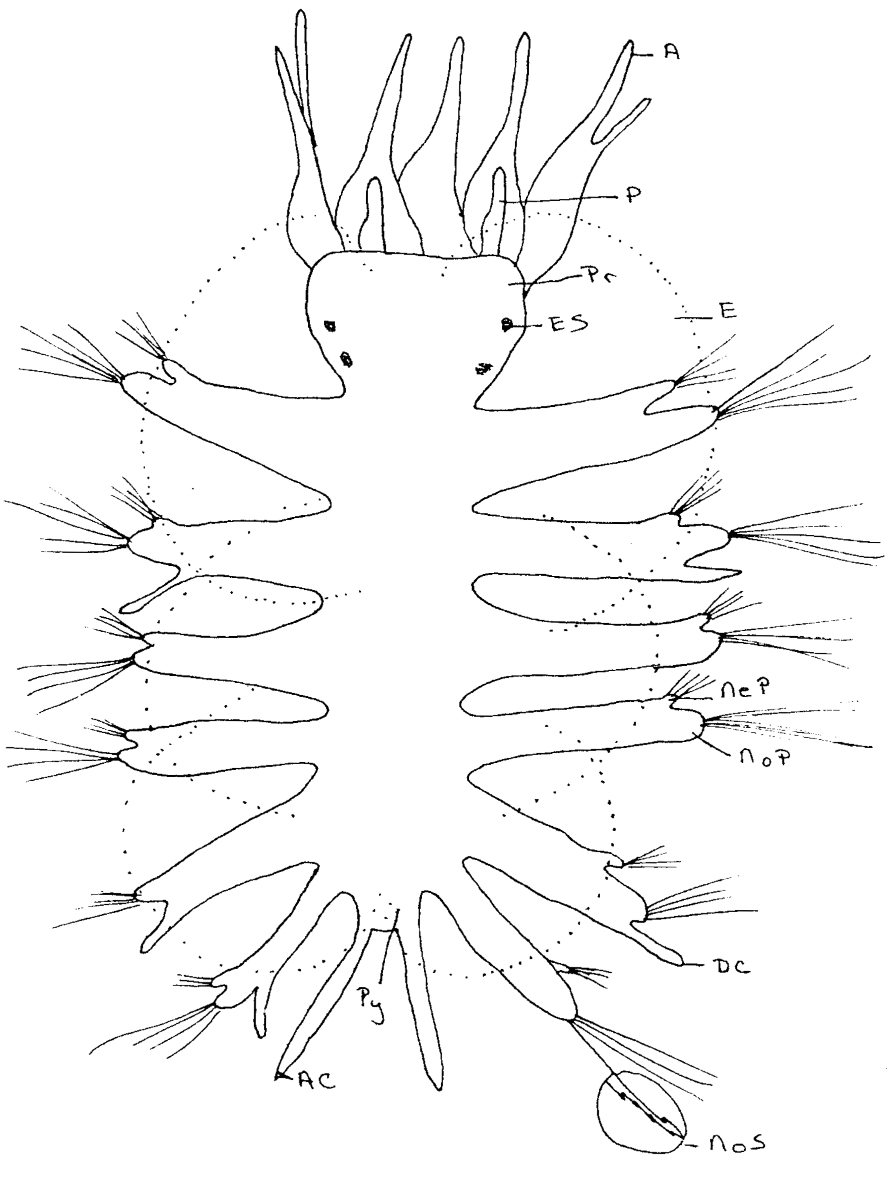


Figure I. Aphroditidae: six setiger stage, dorsal view

A: antenna; AC: anal cirrus; DC: dorsal cirrus; E; elytrum;

ES: eyespot; NeP: neuropodium; NeS: neuroseta; NoP: notopodium

NoS: notoseta; P: palp; Pr: prostomium; Py: pygidium

Family-Phyllodocidae

Description of Larva

A common phyllodocid larva is illustrated in Figure 2. Present are eight setigers, each with paddle-shaped dorsal cirri and compound setae. The prostomium is heart-shaped with a pair of anterior antennae, and one pair of red eyespots. There are two pairs of tentacular cirri and a pair of anal cirri.

Remarks

Thorson (1946) states that the position and number of tentacular cirri can be used as a taxonomic characteristic for the larvae as it is for the adults. This appears to be an age dependent characteristic though, and is only useful in older larvae, such as those ready to metamorphose, and not in younger larvae.

Adult phyllodocids occupy many different habitats, for example, there are the long, slender benthic forms which are found in cracks and crevices; and short, flattened forms which are found in the plankton (Day, 1967).

Genera reported from Hawaii as adults

Eulalia, Eumida, Phyllodoce, Prophyllodoce

References to Larvae

Bhaud, 1967; Cazaux, 1969, 1975; Olive, 1975; Thorson, 1946

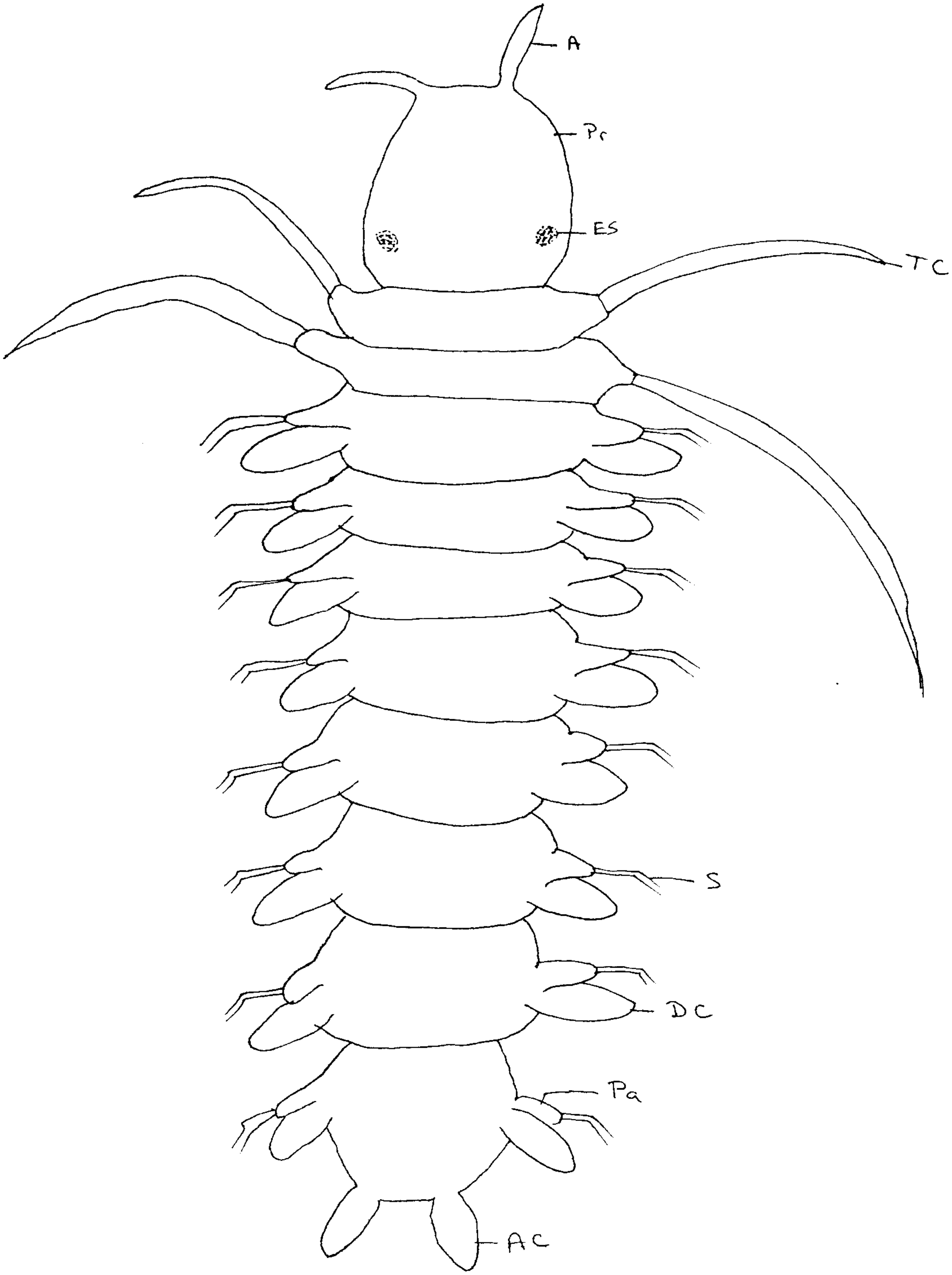


Figure 2. Phyllodocidae: eight setiger stage, dorsal view.

A: antenna; AC: anal cirrus; DC: dorsal cirrus; ES: eyespot;

Pa: parapodium; Pr: prostomium; S: seta; TC: tentacular cirrus

Family-Nereidae

Description of Larva

An example of a three setiger nereid larva (Fig. 3) has a square prostomium with a pair of palps, a pair of antennae and a pair of red eyespots. Also present are a rudimentary jaw and a pair of anal cirri. The most noticeable characteristic of this larval stage is the length of the compound setae (Fig. 4) which are approximately half that of the entire worm and spread out in a fan-like fashion.

Remarks

Life history studies of nereids from temperate waters reveal that the adults swarm, releasing gametes into the water column where external fertilization occurs (Reish, 1957). This swarming stage is called a heteronereid and has been observed in Hawaiian specimens of the genus *Ceratonereis* (per. ob.).

Adult nereids are benthic omnivores, some of which are mud burrowers (Day, 1967).

Genera reported from Hawaii as adults

Ceratonereis, Laeonereis, Namalycastis, Nereis, Perinereis, Platynereis, Pseudonereis

References to Larvae

Bass and Brafield, 1972; Berkeley and Berkeley, 1953; Blake, 1975 c; Dales, 1950; Gilpin-Brown, 1959; Johnson, 1943; Mazurkiewicz, 1975; Read, 1974; Roe, 1975; Smith, 1950; Wilson, 1932

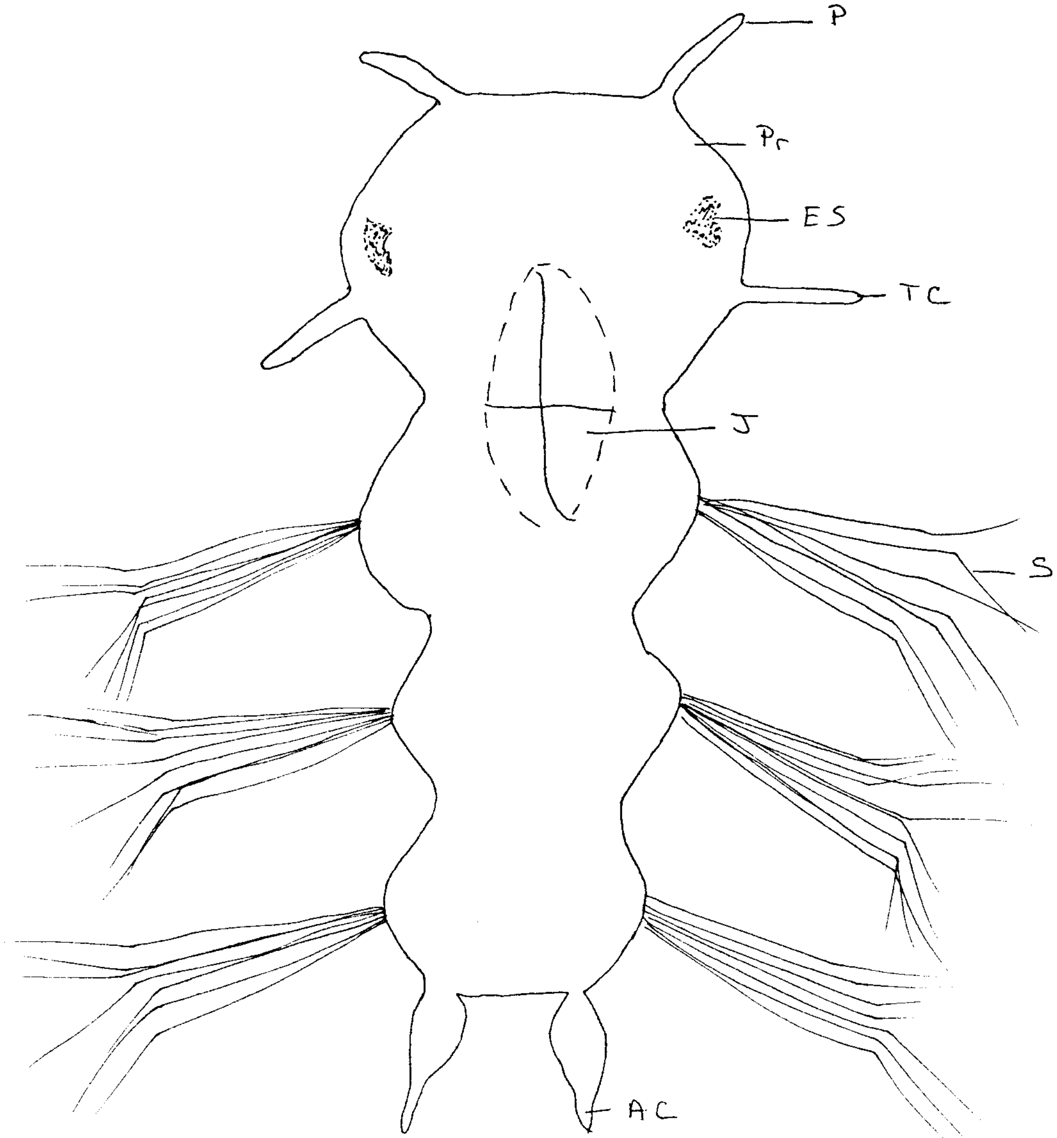


Figure 3. Nereidae: three setiger stage, dorsal view

AC: anal cirrus; ES: eyespot; J: jaw; P: palp; Pr: prostomium;

S: seta; TC: tentacular cirrus

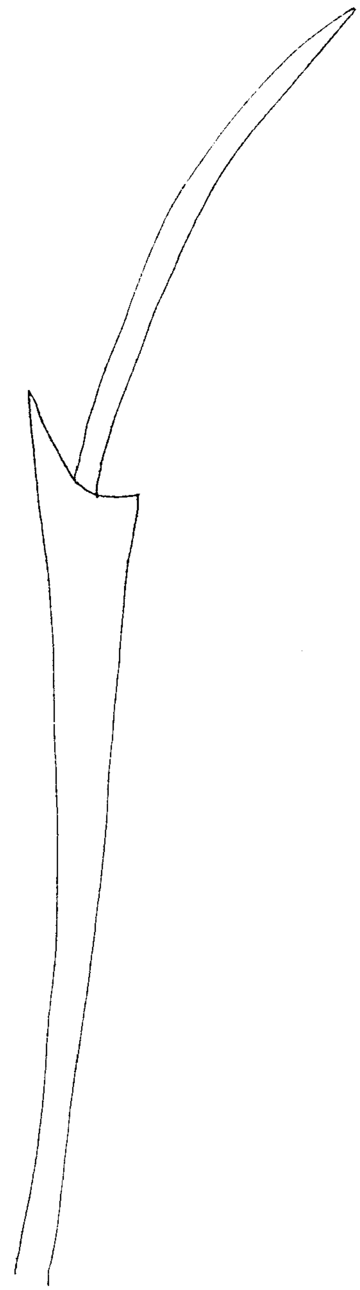


Figure 4. Nereidae: compound seta

Family-Spionidae

The spionids are the most frequently encountered polychaete larvae in Hawaiian plankton. The important characteristics to look for in members of this family are: the number of eyespots, and the color and pattern of pigmentation. Hannerz (1956, 1961) provides taxonomic keys, descriptions and illustrations for many of the spionids and is the best review of the family.

The descriptions of the larvae that follow do not include all stages that one might find in the plankton, rather a characteristic stage, or stages, is described. For a more detailed description of a particular species see the reference list at the end of this section.

A key to the species of the Hawaiian *Polydora* and *Pseudopolydora* is provided.

Key to the planktonic larvae of the Hawaiian *Polydora* and *Pseudopolydora*

1	Bar-shaped dorsal melanophores present; two pairs of black eyespots (Fig. 7)	*Polydora websteri* p. 20
	Bar-shaped dorsal melanophores absent; three pairs of black eyespots	2
2(1)	Dorsal melanophores consist of small dots forming a random pattern (Fig. 8)	*Polydora socialis* p. 24
	Dorsal melanophores are large and stellate (Fig.9) and form rows with an anterior-posterior orientation	3
3(2)	Yellow-white pigment visible under reflected light present; two to four dorsal melanophores/setiger	4
	Yellow-white pigment absent; two dorsal melanophores/setiger (Fig. 9)	*Pseudopolydora paucibranchiata* p.26
4(3)	Two dorsal melanophores/setiger (Fig. 11)	*Pseudopolydora antennata* p.29
	Four dorsal melanophores/setiger (Fig. 12)	*Pseudopolydora pulchra* p.31

Polydora websteri

The three setiger stage is the youngest stage of this worm to be found in the Hawaiian plankton. The body is light brown with an orange gut. The prostomium is blunt with two pairs of dorsal black eyespots and a dorsal medial ridge. There is a single pair of dorsal bar-shaped melanophores on setiger three. The setae are serrated capillaries and extend from each segment to the pygidium. A prototroch and telotroch are visible (Fig. 5).

By the twelve setiger stage the prostomium has become more rounded and a pair of short prostomial palps may be present. There are two dorsal bar-shaped melanophores/setiger from setigers three to six, two dot-shaped dorsal melanophores/setiger from setigers seven to twelve and a median dorsal dot-shaped melanophore on the pygidium (Fig. 6).

In the fourteen setiger stage larva the prostomium is rounded, the lateral pair of eyespots have increased in size and are comma-shaped, the prostomial palps extend to setiger three. The melanophores of setigers seven to fourteen have expanded and are stellate rather than dot-shaped(Fig. 7).

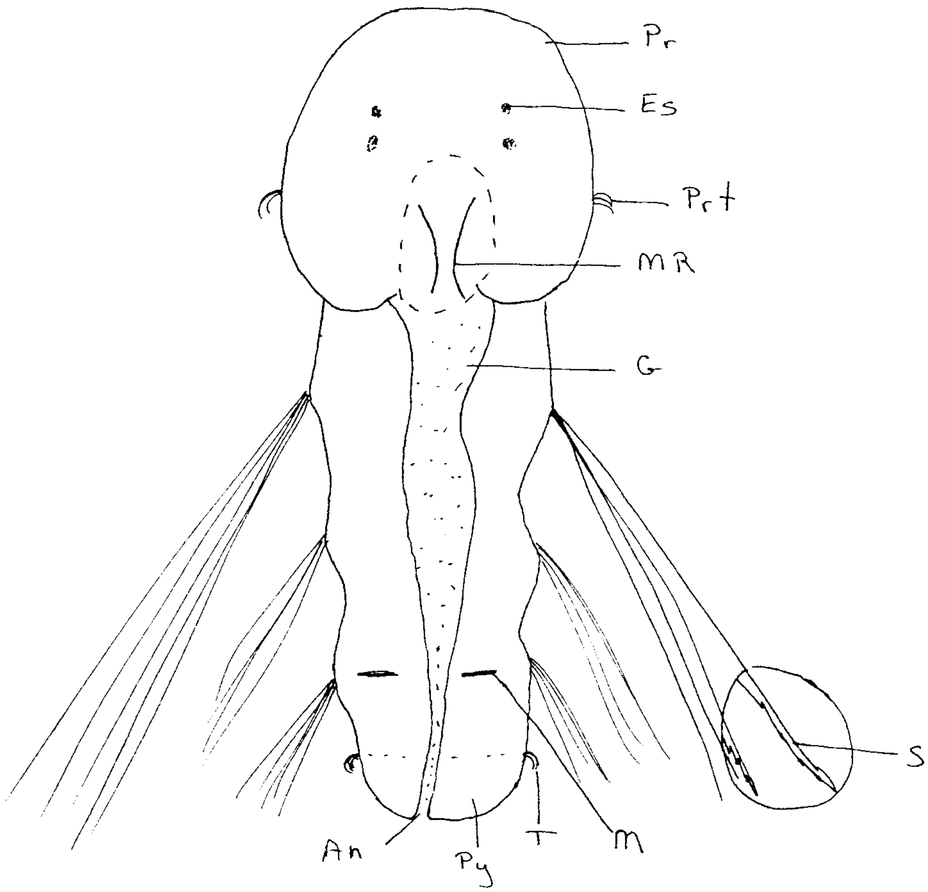


Figure 5. Spionidae: *Polydora websteri*, three setiger stage, dorsal view

An: anus; ES: eyespot; G: gut; M: melanophore; Pr: prostomium;

Prt: prototroch; Py: pygidium; S: seta; T: telotroch

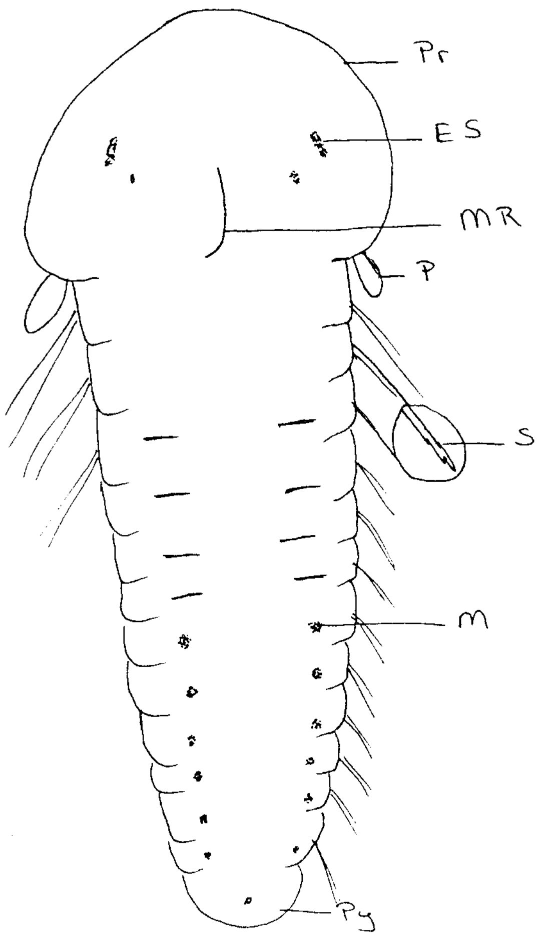


Figure 6. Spionidae: *Polydora websteri*, twelve setiger stage,dorsal view

ES: eyespot; M: melanophore; P: palp; Pr: prostomium; Py:pygidium

S: seta

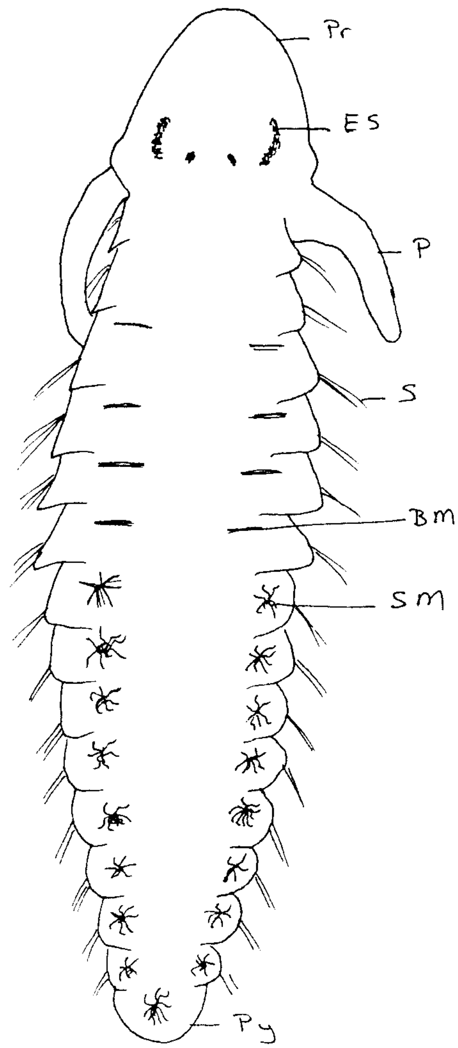


Figure 7. Spionidae: *Polydora websteri*, fourteen setiger stage, dorsal view

BM: bar-shaped melanophore; ES: eyespot; P: palp; Pr: prostomium; Py: pygidium; S: seta; SM: stellate melanophore

Polydora cf. socialis

The larva of this worm is transparent or white with dorsal pigmentation consisting of randomly arranged small dot-shaped melanophores. The fifteen setiger stage larva has three pairs of black eyespots, and a pair of prostomial palps which extend to setiger five. The setae are smooth,and irridescent with those of setiger one extending beyond the pygidium (Fig. 8).

Larvae of *Polydora socialis* are reported to have a yellow-brown pigment on the pygidium (Blake, 1969b);this was not seen in the Hawaiian specimens but Blake (per. comm.) says that the Hawaiian form is either *Polydora socialis* or a close relative.

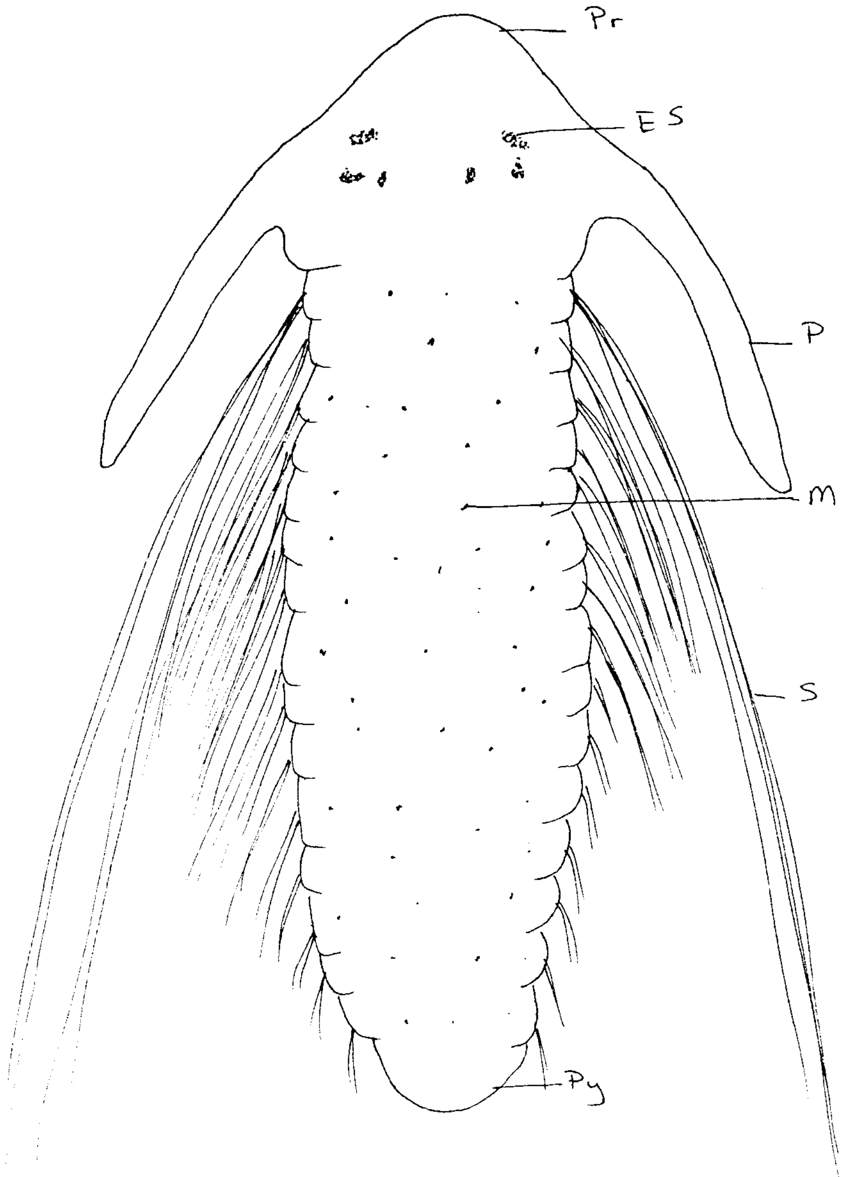


Figure 8. Spionidae: *Polydora websteri*, fifteen setiger stage, dorsal view

ES: eyespot; M: melanophore; P: palp; Pr: Prostomium; Pygidium; S: seta

Pseudopolydora paucibranchiata

The eleven setiger larva of *Pseudopolydora paucibranchiata* has a rounded prostomium with three pairs of black eyespots, a median ridge and a pair of short prostomial palps. At the junction of each palp with the prostomium is a dorsal stellate melanophore. There is a median dorsal stellate melanophore on setiger one and the pygidium as well as two lateral dorsal stellate melanophores/setiger from setigers two to eleven (Fig. 9). The setae are serrated capillaries.

A typical fifteen setiger larva is approximately three times as long as wide. The body is tan, the prostomium is blunt with three pairs of black eyespots and a pair of prostomial palps may be present. There is a single median dorsal stellate melanophore on setiger one and the pygidium and two lateral dorsal melanophores/setiger from setiger two to fifteen (Fig. 10). On the ventral surface there is a single median stellate melanophore on setiger six. Yellow-white pigment (visible under reflected light) appears on the dorso-lateral region of the prostomium, setiger one and the pygidium (not shown in Fig. 10). On the palps there is scattered yellow pigment and small dot-shaped melanophores. The larval notosetae are irridescent and serrated with those of setiger one being the longest, extending to setiger fifteen.

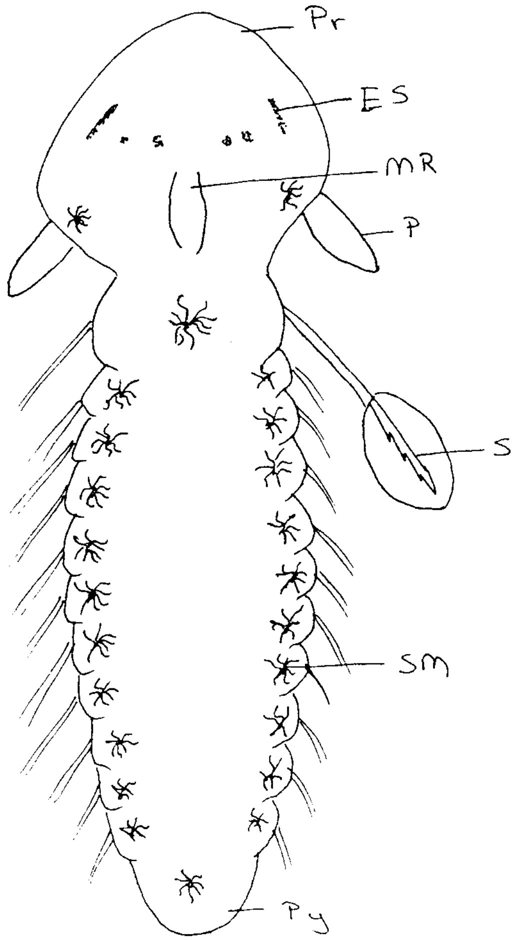


Figure 9. Spionidae: *Pseudopolydora paucibranchiata*, eleven setiger stage, dorsal view

ES: eyespot; MR: medial ridge; P: palp; Pr: prostomium; Py: pygidium; S: seta; SM: stellate melanophore

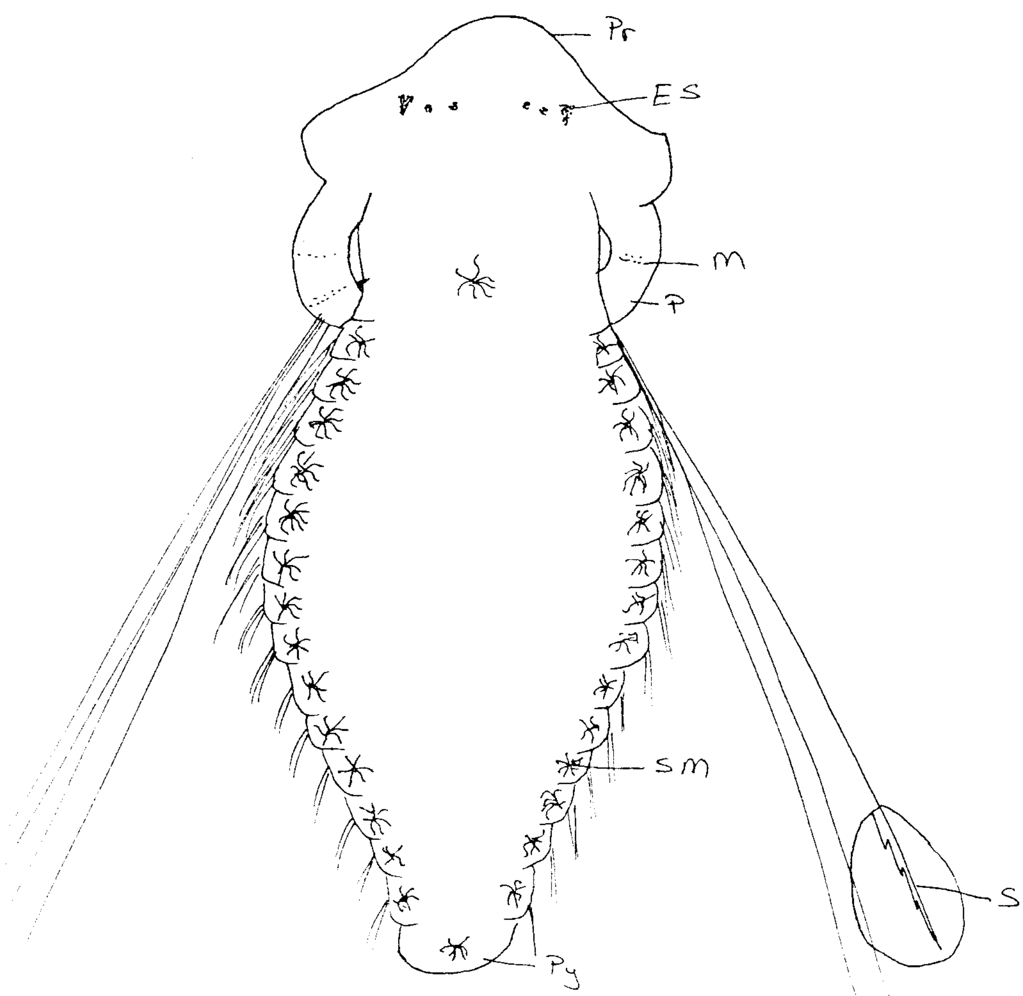


Figure 10. Spionidae: *Pseudopolydora paucibranchiata*, fifteen setiger stage, dorsal view

ES: eyespot; M: melanophore; P: palp; Pr: prostomium; Py: pygidium; S: seta; SM: stellate melanophore

Pseudopolydora antennata

The eight setiger stage of this worm is approximately twice as long as wide, the body is silver-grey. The dorsal pigmentation consists of two stellate melanophores/setiger from setigers three to eight and a median stellate chromatophore on the pygidium (later stages also have a median stellate melanophore on the prostomium)(Fig. 11). There is no yellow-white pigment as in *Pseudopolydora paucibranchiata*. The prostomium is rounded with three pairs of black eyespots, the lateral two pairs may fuse to form large compound eyespots. The setae are long, smooth and irridescent, with those of setiger one being more numerous ond longer than those in the succeeding setigers. The prostomial palps, when present, are short, not extending beyond setiger two.

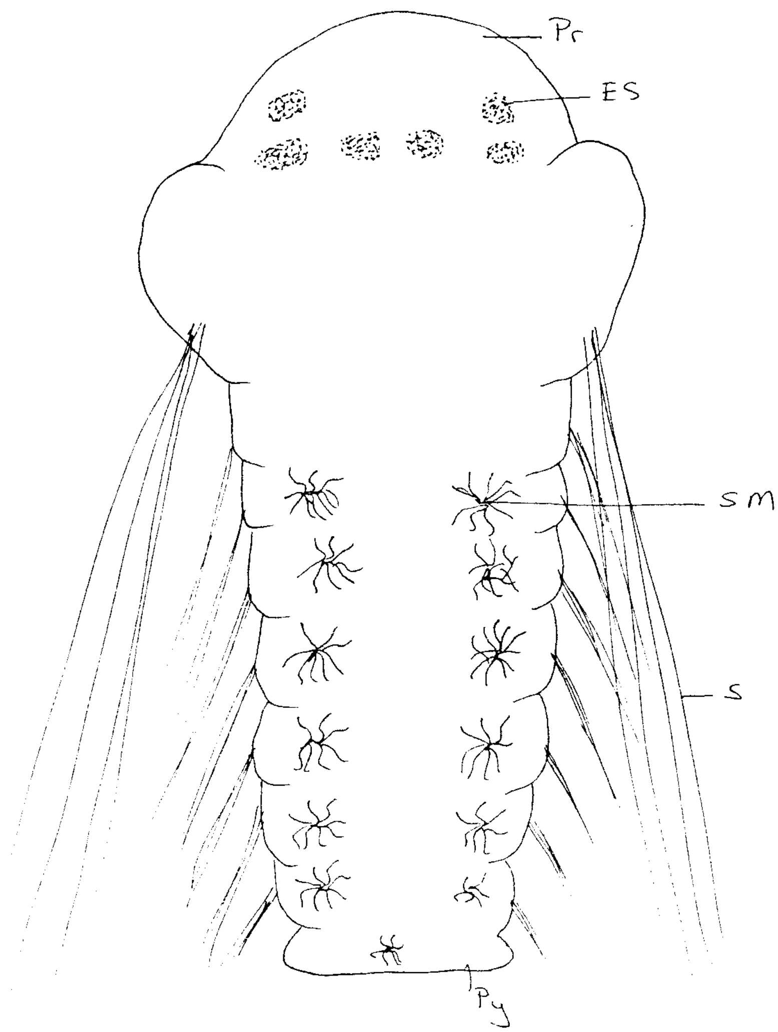


Figure 11. Spionidae: *Pseudopolydora antennata*, eight setiger stage, dorsal view

ES: eyespot; Pr: prostomium; Py: pygidium; S: seta; SM: stellate melanophore

Pseudopolydora pulchra

The fourteen setiger stage larva is approximately twice as long as wide, the body is silver-grey in color with a blunt prostomium and three pairs of black eyespots. The prostomial palps do not extend beyond setiger three. There is a dorsal medial stellate melanophore on the prostomium and the pygidium as well as four dorsal stellate melanophores/setiger from setigers one to fourteen (Fig. 12). Ventrally there is yellow-white pigment on the prostomium, at the base of the palps and on the pygidium and on the middle setigers (not shown in Fig. 12). The setae are long, smooth and irridescent.

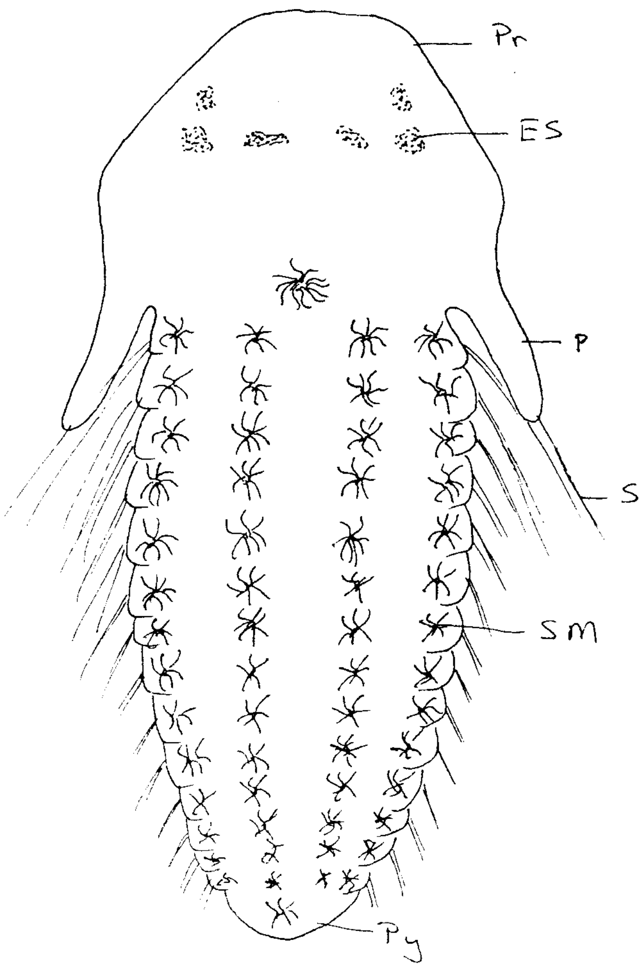


Figure 12. Spionidae: *Pseudopolydora pulchra*, fourteen setiger stage, dorsal view.

ES: eyespot; P: palp; Pr: prostomium; Py: pygidium; S: seta; SM: stellate melanophore

Remarks

Most members of the genus *Polydora* lay their fertilized eggs in some type of protective capsule (Hannerz, 1956). Blake (1969b)reported that *Polydora websteri* and *Polydora socialis* form similar bead-like egg capsules which are deposited within the parent's tube in a string, with each capsule partially connected to the tube wall. In Hawaiian specimens of *Polydora websteri* the egg capsules contain an average of 25 eggs and are attached to the wall of the parent's tube with the dorsal surface of the parent facing them. The larvae of both *Polydora websteri* and *Polydora socialis* are released from the egg capsule at the three setiger stage (Blake, 1969b).

The type of egg capsule and age of release are the same for *Pseudopolydora paucibranchiata* as for the two species of *Polydora* (Blake and Woodwick, 1975).

The development and settlement behavior of *Polydora websteri* has recieved special attention because it bores into oyster shells often making them unmarketable. Further investigation is necessary to eliminate it as a pest of oysters.

Spionids are detritivores which form mucous lined burrows in soft substrates such as mud (Day, 1967) or bore into calcium carbonate substrates (Blake and Evans, 1973).

Genera reported from Hawaii as adults

Aonides, Polydora, Prionospio, Pseudopolydora, Spio, Spiophanes

References to Larvae

Blake, 1969b; Blake and Evans, 1973; Blake and Woodwick, 1975; Casanova, 1952; Day, 1934; Dean and Hatfield, 1963; Guérin, 1970, 1972; Hannerz, 1956, 1961; Hatfield, 1965; Hopkins, 1958; Rullier, 1960, 1963; Simon, 1967, 1968; Thorson, 1946; Wilson, 1928; Woodwick, 1960

Family-Chaetopteridae

Description of Larvae

The larva of *Chaetopterus sp.* is approximately 1mm long at the stage where there are six setigers in the anterior body region (Fig. 13) The body is divided into three regions by two ciliary bands, and tapers posteriorly into an anal projection (Figs. 13&14). The larva is ciliated and can move rapidly through the water. On the prostomium an apical tuft is visible, and there are two pairs of red eyespots. Thorson (1946) describes a third pair of red eyespots on the dorsal margin of the prostomium of *Chaetopterus variopedatus* but this was not seen in the Hawaiian larva. This third pair of eyes is much smaller than the other two and it may not be noticeable in the actively moving live specimens and the Hawaiian specimen may be a different species than the one Thorson (1946) describes. There is a pair of short prostomial palps on the dorsal surface of the larva (Figs. 13&14). The setae are hooded hooks.

Remarks

Adult chaetopterids feed by trapping food particles in a mucus sac suspended between the parapodia of the middle body region. Their tube may be of sand grains or parchment like material (Day, 1967).

According to Thorson (1946) *Chaetopterus variopedatus* undergoes external fertilization and development of the larva takes place in the plankton. The length of time spent in the plankton depends on the available food. After metamorphosis the worm becomes benthic and builds a mucous tube.

Genera reported from Hawaii as adults

Chaetopterus, Mesochaetopterus, Phyllochaetopterus

References to Larvae

Bhaud, 1966; Marsden, 1960; Thorson, 1946

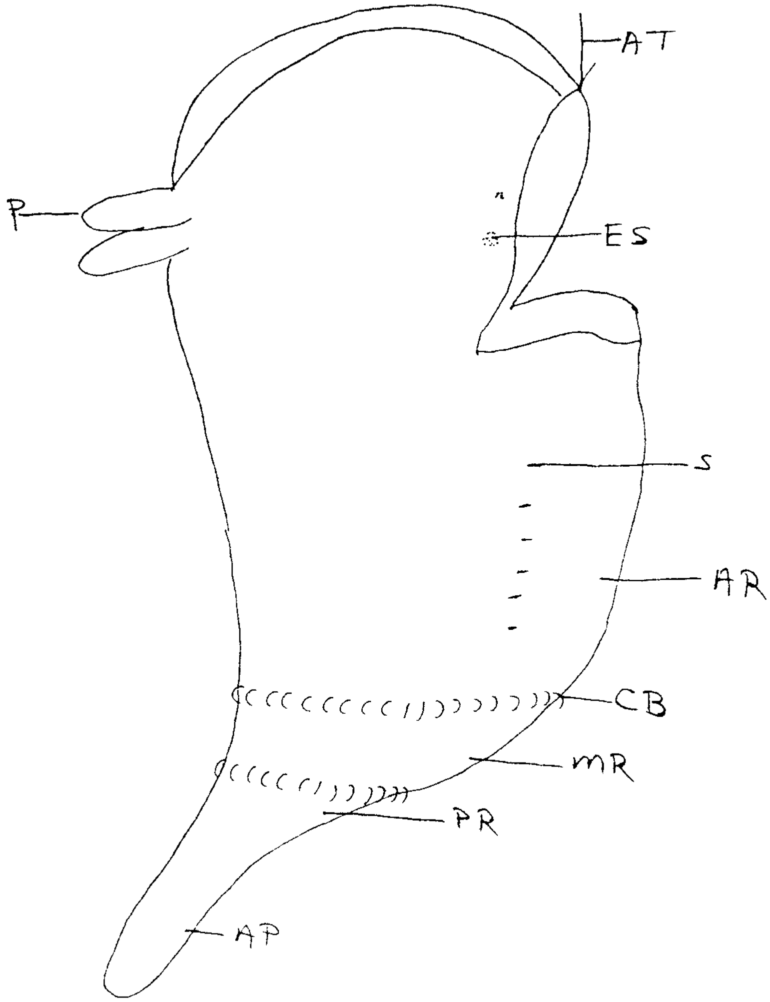


Figure 13. Chaetopteridae: *Chaetopterus sp.*, lateral view
AP: anal projection; AR: anterior region; AT: apical tuft; CB: ciliary band; ES: eyespot; MR: middle region; P: palp; PR: posterior region; S: seta

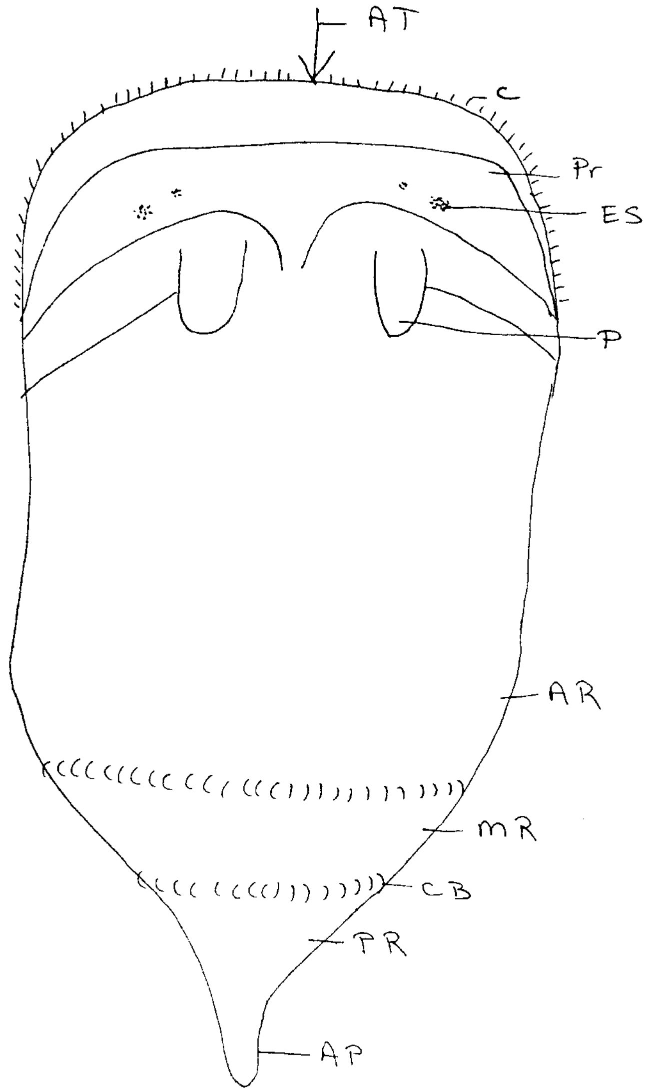


Figure 14. Chaetopteridae: *Chaetopterus sp.*, dorsal view

AP: anal projection; AR: anterior region; AT: apical tuft; C: cilia; CB: ciliary band; ES: eyespot; MR: middle region; P: palp;PR: posterior region; Pr: prostomium

Family-Capitellidae

Description of Larva

The larva of *Capitella capitata* (Fig. 15) is cylindrical with a conical prostomium and a rounded pygidium. A pair of red eyespots is located on the prostomium which lacks any antennae, palps or other projections. There are thirteen setigerous segments with simple capillary setae (Fig. 16a) in the anterior segments and hooded hooks (Fig. 16b) in the posterior ones. There is a ciliary band at the junction of the prostomium with the body and also at the junction of the pygidium with the body. These ciliary bands enable the larva to move rapidly within the water column. The body color of the larva is light brown and there may be red, black or blue pigment spots on the prostomium and pygidium.

Remarks

The eggs of *Capitella capitata* float free in the coelom of the female, fertilization is internal. The zygotes are extruded from the female and cemented with a gelatinous material to the surrounding mud tube. Larvae hatch at the thirteen setiger stage (Thorson, 1946).

Grassle and Grassle (1976) investigated the electrophoretic patterns for eight enzymes of *Capitella capitata* larvae and found a complex of six sibling species that lacked common alleles and had different life histories. In most cases the size of eggs and the brood size differed and in all cases the time spent in the plankton varied

Genera reported from Hawaii as adults

Capitella, Dasybranchus, Notomastus

References to Larvae

Guérin and Massé, 1974; Grassle and Grassle, 1976; Thorson, 1946; Wilson, 1933

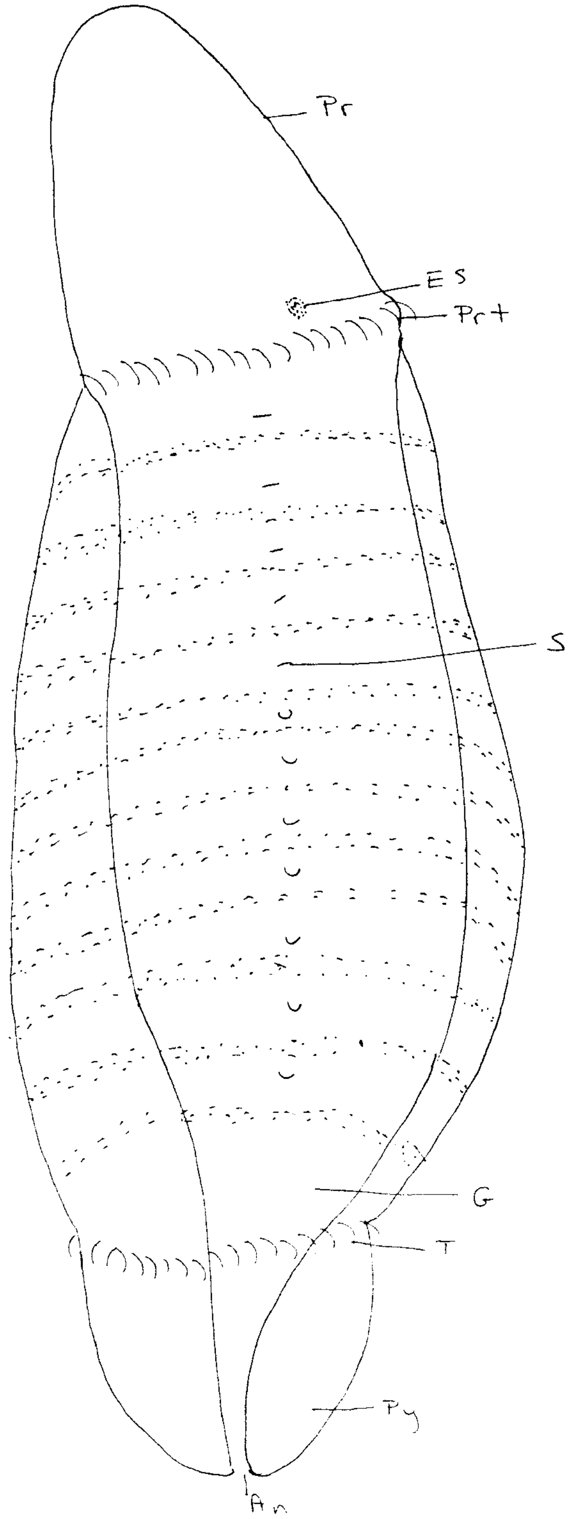
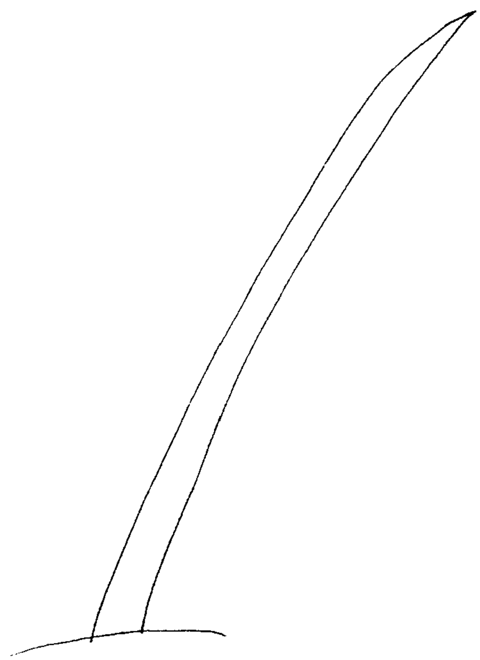


Figure 15. Capitellidae: *Capitella capitata*, thirteen setiger stage, lateral view

An: anus; ES: eyespot; G: gut; Pr: prostomium; Prt: prototroch;Py: pygidium

S: seta; T: telotroch

a.



b.

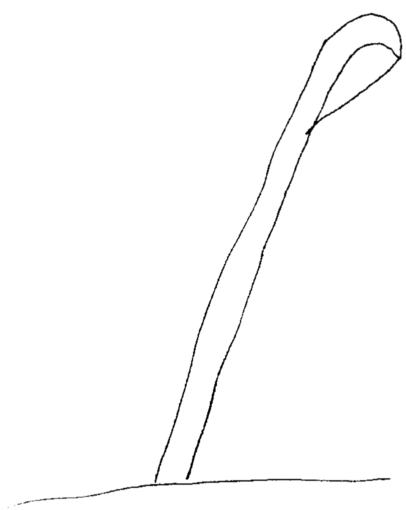


Figure 16. Capitellidae; setae of *Capitella capitata*

a: simple capillary

b: simple hooded hook

Family-Opheliidae

Description of Larvae

A ten setiger larva of *Polyophthalmus pictus* (Fig. 17) has a rounded prostomium with three black eyespots. Parapodia are rounded and the setal bundles are composed of capillary setae with the central seta longer than those at the periphery of the bundle (Fig. 17). The pygidium has three anal cirri.

Remarks

Adult opheliids are elongate and tapered at both ends; they are white or pink in color and burrow in mud and sand. Sand grains and organic material have been observed in the guts of opheliids indicating that they are detritivores.

Genera reported from Hawaii as adults

Armandia, Polyophthalmus

References to Larvae

Guérin, 1971, 1973; Wilson, 1948, 1953, 1954, 1955

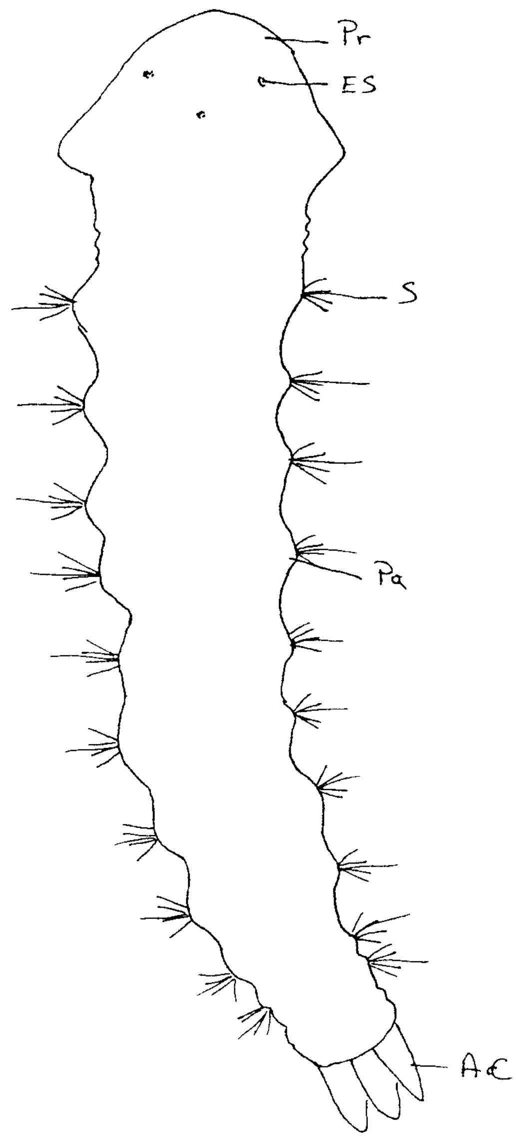


Figure 17. Opheliidae: *Polyopthalmus pictus*, ten setiger stage, dorsal view

AC: anal cirrus; ES: eyespot; Pa: parapodium; Pr: prostomium; S: seta

Family-Serpulidae

Description of Larva

Trochophores and three setiger stage larvae of serpulids are often encountered in Hawaiian plankton. It is seldom possible to identify these larvae to genus or species because they are so young, it is necessary to raise them through metamorphosis. The larva of *Spirobranchus giganteus* is typical of serpulid larvae and will be used to illustrate the larvae of this family. The following description is based on larvae reared in the laboratory by J. White from gametes obtained from mature *Spirobranchus giganteus* collected at Kahe Point, Oahu.

The early trochophore is top-shaped with the pretrochal and posttrochal hemispheres of equal size (Fig. 18a). The prototroch and apical tuft are visible at this stage. Eight days after fertilization the posttrochal region has started to elongate and a pair of red eyespots is visible dorsally on the pretrochal hemisphere (Fig. 18b). The fourteen day larva has three setigerous segments (Fig. 19) and the posttrochal region has continued to elongate and may have orange-brown pigmentation. From between fifteen to twenty days of age the larva will settle out of the water column and form a transparent tube (White, 1975). The larvae of *Spirobranchus giganteus* have not been reared beyond this early settlement stage (Marsden, 1960; White, 1975).

Remarks

Adult serpulids are tubicolous, suspension feeders. Their calcareous tubes may be straight and attached only at the base as in *Filograna implexa* or coiled and attached to the substrate along the entire length of the tube as in the spirorbids.

Serpulids, such as *Hydroides elegans* and *Hydroides dirampha,* are often found on marine and harbor structures, such as pier pilings, boat hulls, and the bottom of buoys (Bailey-Brock, 1976).

Serpulids display a fortnightly reproductive rhythm based on tidal cycles. Garbarini (1933) observed that *Spirorbis borealis* larvae are released and settle at the moons quarters and have established their tubes before the spring tides. Straughan (1968) found that the larvae of *Ficopomatus enigmaticus* settle on the spring tides in the Brisbane River, Australia.

Most members of this family have one radial of the branchial crown modified to form an operculum which is used to plug the tube when the worm is retracted. The operculum is also used as a brood pouch by some spirorbids. The methods of brood protection--egg-string, operculum incubation, and thoracic brood pouch incubation--have been used as a basis for reclassifying the spirorbids (Bailey, 1969).

Genera reported from Hawaii as adults

Eulaeospira, Eupomatus, Ficopomatus, Filograna, Hydroides, Janua, Pileolaria, Pileolaeospira, Pomatoleios, Protolaeospira, Protula, Serpula, Spirobranchus, Spirorbis, Vermiliopsis

References to Larvae

Gee, 1962, 1965; Gee and Knight-Jones, 1962; Knight-Jones, 1951, 1953; Nott and Parkes, 1975; Quiévieux, 1962; Rothlisberg, 1974; Rullier, 1960; Sentz-Braconnot, 1964; Straughan, 1968; White, 1975; Wisely, 1958, 1960

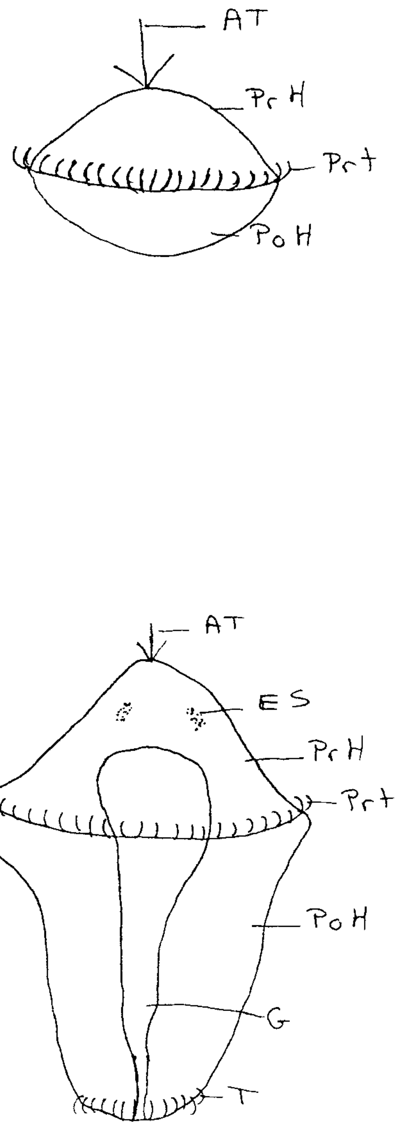


Figure 18. Serpulidae: *Spirobranchus giganteus*;

a: trochophore, lateral view
b: eight day old larva, dorsal view

AT: apical tuft; ES: eyespot; G: gut; PoH: posttrochal hemisphere;

PrH: pretrochal hemisphere; Prt: prototroch; T: telotroch

(After White, 1975)

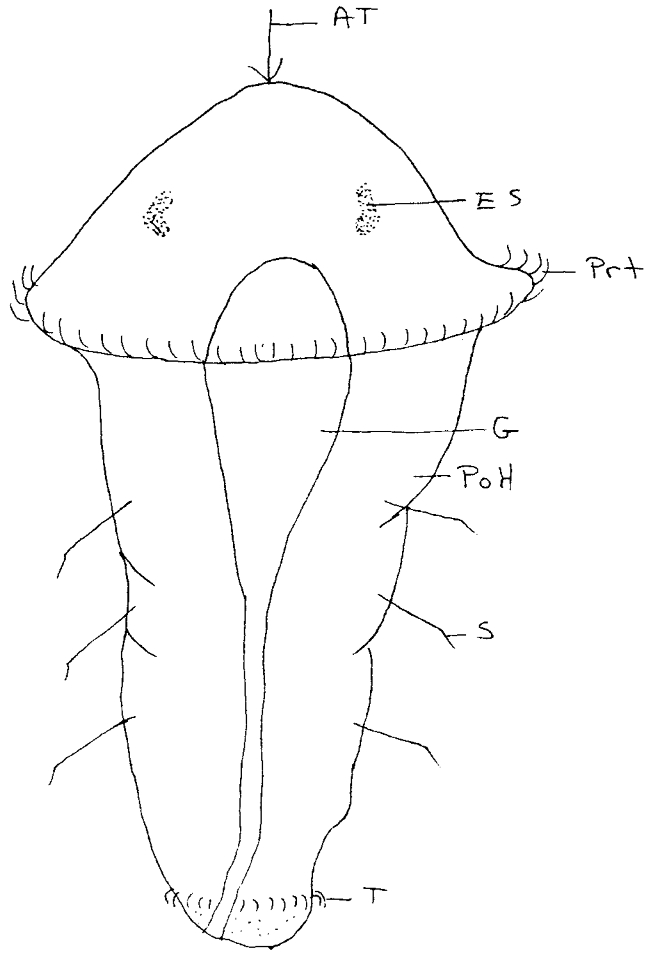


Figure 19. Serpulidae: *Spirobranchus giganteus*, three setiger stage, dorsal view

AT: apical tuft; ES: eyespot; G: gut; PoH: posttrochal hemisphere; PrH: pretrochal hemisphere; Prt: prototroch; S: seta; T: telotroch

(After White, 1975)

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APPENDIX I

GLOSSARY

Anal cirrus-	elongated projection arising from the last segment or pygidium (Fig. 1)
Antenna-	sensory projection arising from the anterior or dorsal surface of the prostomium (Fig. 2)
Apical tuft-	bundle or group of a few cilia projecting from the anterior most portion of the larva (Fig. 18a)
Capillary seta-	hair-like bristle (often used to mean all long, slender, tapering setae) (Fig. 16a)
Coelom-	body cavity
Chromatophore-	pigment cell or group of cells (see: Melanophore)
Cirrus-	respiratory and tactile appendage of the setiger (Fig. 2)
Compound seta-	jointed bristle (Fig. 4)
Elytrum-	dorsal sclae (Fig. 1)
Geniculate seta-	seta that is bent but not jointed (Fig. 19)
Hooded hook-	seta that is curved distally and is covered with a chitinous envelope (Fig. 16b)
Melanophore-	black pigment cell or group of cells (Fig. 7)
Neuropodium-	ventral section of parapodium (Fig. 1)
Neuroseta-	seta of the neuropodium (Fig. 1)
Notopodium-	dorsal section of parapodium (Fig. 1)
Notoseta-	seta of the notopodium
Palp-	paired projections arising from the prostomium used for food gathering and tactile purposes (Figs. 3 and 7)

Parapodium-	lateral, segmental foot-like projections bearing setae (Fig. 2)
Posttrochal hemisphere-	the region posterior to the prototroch(Fig. 18a)
Pretrochal hemisphere-	region anterior to the prototroch (Fig. 18a)
Prostomium-	that part of the head anterior to the mouth (Fig. 5)
Prototroch-	ring of cilia anterior to the mouth(Fig. 18a)
Pygidium-	segment bearing the anus (Fig. 5)
Serrated seta-	seta with one or more edges notched like a saw (Fig. 5)
Seta-	bristle-like structure projecting from the parapodium, used for locomotion and defense (Fig. 1)
Setiger-	segment bearing seta (Fig. 2)
Simple seta-	unjointed bristle (Fig. 16)
Stellate-	radiating, star-shaped (Fig. 9)
Telotroch-	ring, or tuft, of cilia near the anus(Fig. 18b)
Trochophore-	free-swimming pelagic larval stage, usually shaped like a top (Fig. 18a)

PLATES

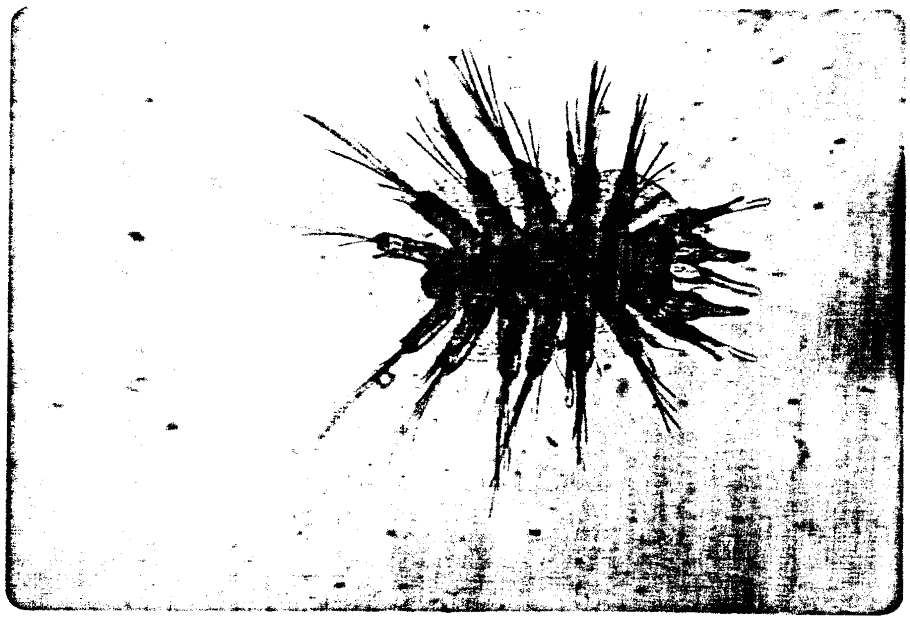


Plate I

Aphroditidae: six setiger stage larva, dorsal view

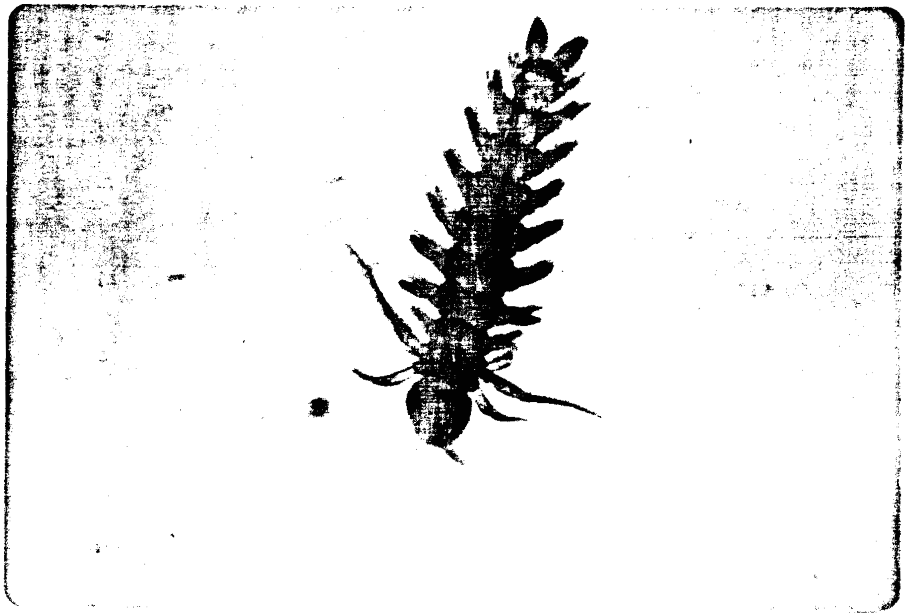


Plate II

Phyllodocidae: eight setiger stage larva, dorsal view

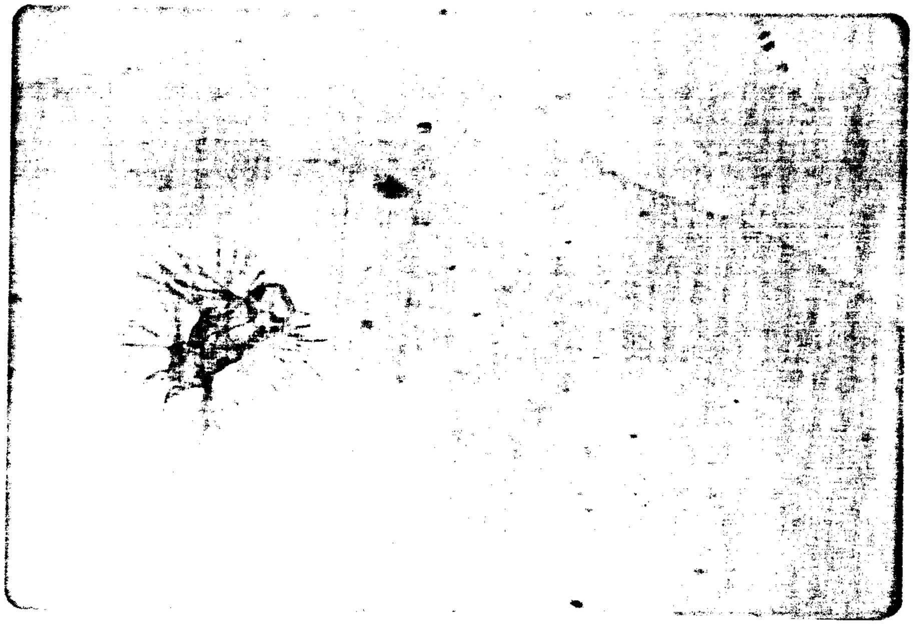
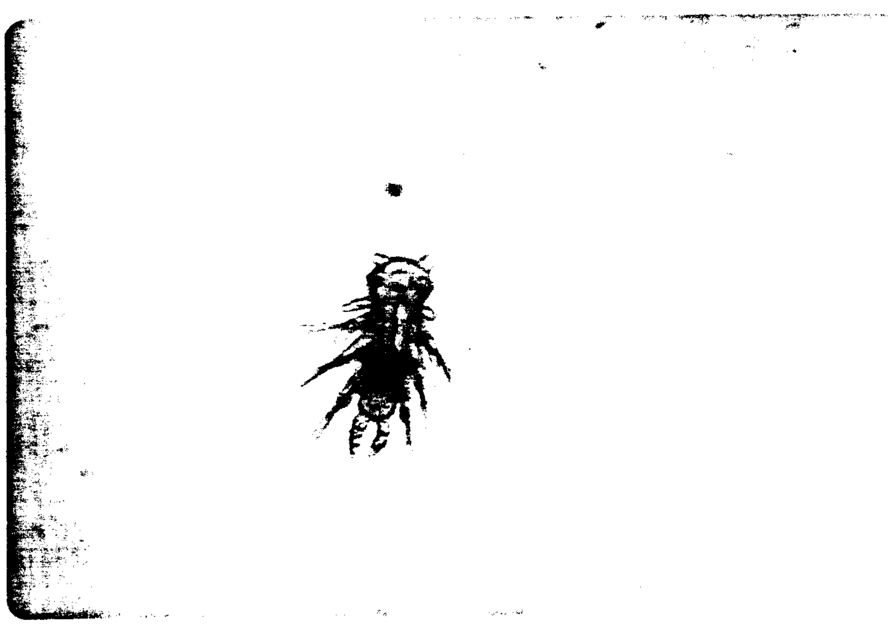


Plate III

Nereidae: a: three setiger stage larva, dorsal view

b: three setiger stage larva, ventral view



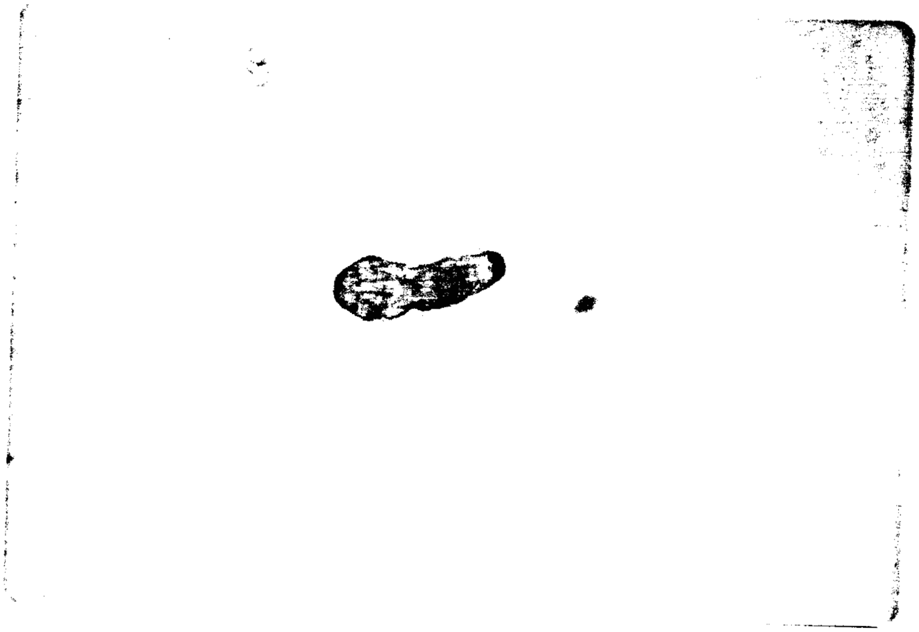
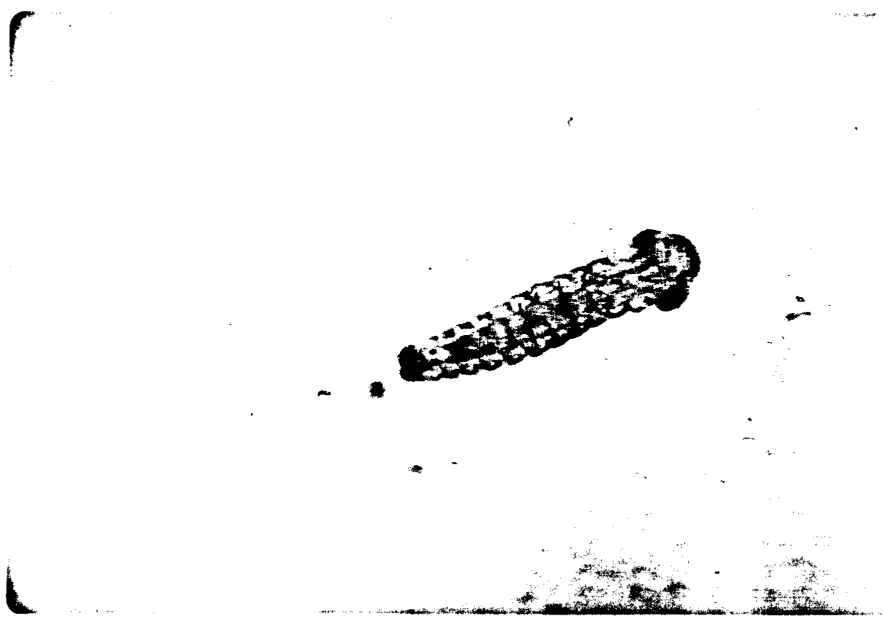


Plate IV

Spionidae: *Polydora websteri*

a: three setiger stage larva, dorsal view

b: twelve setiger stage larva, dorsal view



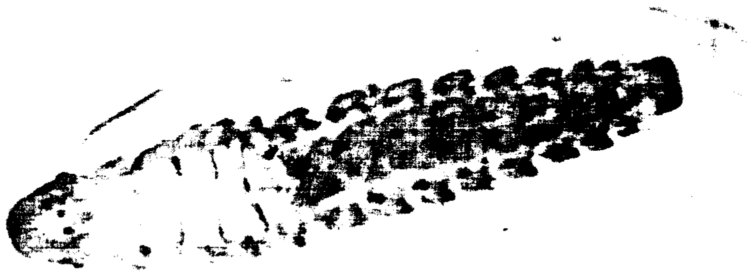


Plate IV

Spionidae: *Polydora websteri*

c: fifteen setiger stage larva, dorsal view

Plate V

Spionidae: *Polydora socialis*- sixteen setiger stage larva, dorsal view

Plate VI

Spionidae:*Pseudopolydora paucibranchiata*

a: twelve setiger stage larva, dorsal view

Plate VI

Spionidae: *Pseudopolydora paucibranchiata*

b: fifteen setiger stage larva, with prostomial palps, dorsal view

c: fifteen setiger stage larva, without prostomial palps, dorsal view

Plate VII

Spionidae: *Pseudopolydora antennata*- eight setiger stage, larva, dorsal view

Plate VIII

Spionidae:*Pseudopolydora pulchra* -twelve setiger stage larva, dorso-lateral view

Plate IX

Opheliidae: *Polyophthalmus*- twelve setiger stage larva, dorsal view

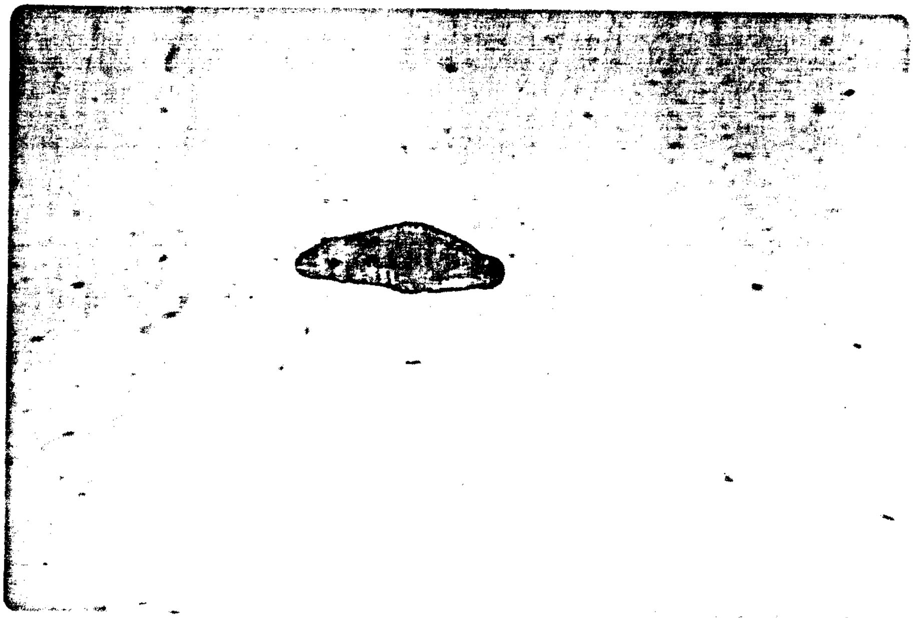


Plate X

Capitellidae: *Capitella capitata*

a: Thirteen setiger stage larva, lateral view

b: Thirteen setiger stage larvae "stretching", lateral view

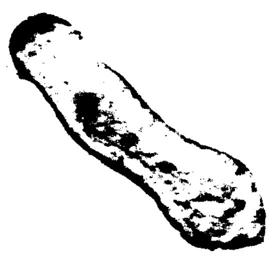


Plate XI

Serpulidae: *Spirobranchus giganteus*

a: Trochophore, lateral view

b: Trochophore, anterior-dorsal view

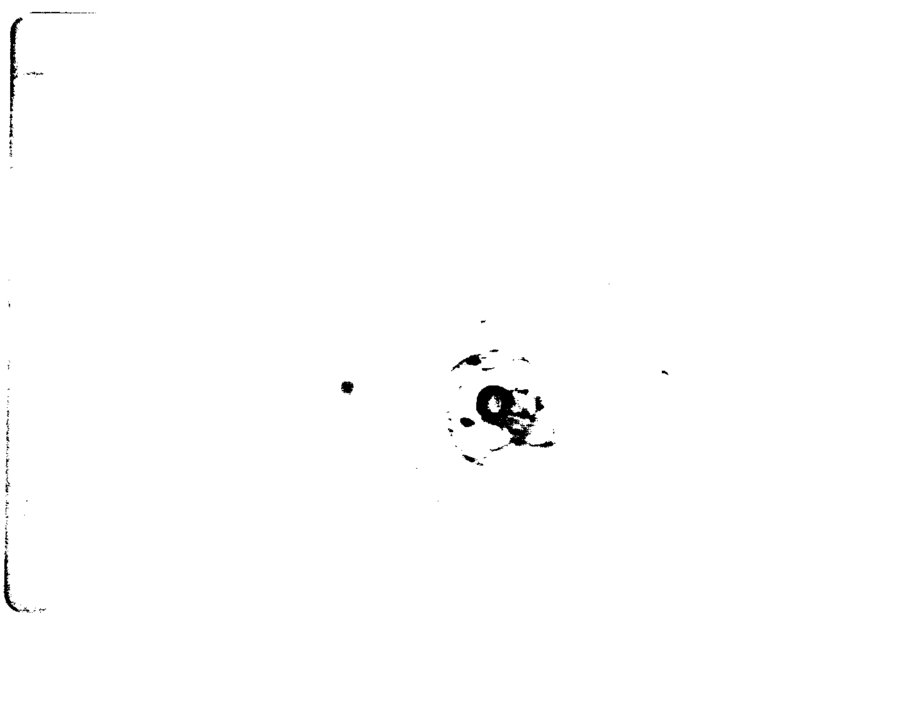


Plate XI

Serpulidae: *Spirobranchus giganteus*

c: three setiger stage larva, lateral view